there consumed in the chemical changes in progress. The data available are insufficient to render it possible to differentiate between these three kinds of loss.

Table 7 is in a form to facilitate this study, and from it are extracted most of the items in the following table, which represents the entire catchment basin above Bohio during the six years for which complete data are available. The residue found by subtracting direct flow and ground water from rainfall is denominated evaporation, which is classed as negative when the rainfall becomes less than the outflow, by reason of ground water.

TABLE 8.—*Disposition of rainfall in the Valley of the Chagres.*

Month.	Rainfall.	Outflow, in inch-miles.		Evaporation.	
		Direct.	Ground water.	Inch-miles.	Per cent of rainfall.
	Inches.				
January	5.78	1.70	5.43	Negative.	.....
February	1.06	0.27	1.82	Negative.	.....
March	1.34	0.36	1.14	Negative.	.....
April	2.95	0.37	1.52	1.06	36
May	10.47	3.14	0.21	7.12	68
June	10.63	3.24	1.50	5.89	55
July	15.51	4.72	2.52	8.27	53
August	14.21	4.18	3.90	6.13	43
September	11.45	3.38	3.95	4.12	36
October	14.21	3.16	6.40	4.65	36
November	17.01	5.10	7.66	4.25	25
December	6.92	2.05	5.72	Negative.	.....
Year	111.54	31.67	41.77	38.10	34

It is to be noted that the monthly estimates for evaporation in Table 8 are subject to the criticism that the ground-water flow due to rain falling in previous months is included in the computations for each month, and must vitiate the results. If the rate of flow through the ground were definitely known this error could be corrected, but this is a refinement too uncertain to be attempted. The steady decrease in the percentage column from month to month in the rainy season is doubtless due to this cause, and the value for June and July, when there is little ground water, is, say, about 55 per cent, which is probably quite closely the average for the entire rainy season. The average value for the year, 34 per cent of the rainfall, is not vitiated by ground water, as it represents a complete cycle, and its small figure is due to the absence of surface water to be evaporated in the dry season. The reduced humidity then observed confirms this view.

It would appear, therefore, from this study of the rainfall above Bohio, that the annual loss by evaporation (as above defined) averages 3.18 inch-miles per month, corresponding to a flow from the entire 700 square miles of 1995 cubic feet per second, to compare with 1657 cubic feet of direct flow and 2117 cubic feet of ground-water flow. In other words, of the entire rainfall about one-third disappears, another third flows off directly by the channel of the Chagres, and the remaining third, after a retardation of perhaps three months by its passage through the soil, ultimately reaches the bed of the river as ground water.

Furthermore, the 3.18 inches lost monthly by evaporation correspond to a daily loss of 0.11 inch; and as this applies to the general surface of the country, not to water surfaces directly exposed to the atmosphere, it is in good accord with the measurements above quoted made by the Isthmian Canal Commission in Nicaragua where the climatic conditions are quite similar. Such figures certainly show that the high humidity observed on the Isthmus is easily explained, notwithstanding the large capacity for moisture in air of such high temperature.

To enable a comparison to be made between these results and those noted in more temperate regions, advantage is taken of the summary for 12 American streams given in the able paper on the "Relation of rainfall to run-off," by George W. Rafter, which forms "Water supply and irrigation paper," No. 80, of the United States Geological Survey, 1903. The available data respecting these streams were not sufficient to permit a quantitative estimate of the ground-water flow, but Mr. Rafter in his general summary of the subject states the following conclusions, which are amply confirmed by the Chagres records: "When rainfall is below the mean for several months ground water may be expected to become continuously lower, with the result that the flow of streams will be less." And, "The ground water must be taken into account in order to understand all the peculiarities of flow. A very important effect of forests is in increasing the ground-water flow." The following table is abstracted from that on page 99 of Mr. Rafter's paper, the unit being inches per square mile of the basin. The figures for the Chagres are repeated for convenience of comparison.

TABLE 9.—*Average annual rainfall, outflow, and evaporation in the catchment basin.*

Streams.	Years observed.	Catchment area.	Rainfall.	Outflow.	Evaporation.
		Sq. miles.	*Inches.*	*Inches.*	*Inches.*
Muskigum River	8	5,828.0	39.7	13.1	26.6
Genessee River	9	1,070.0	40.3	14.2	26.1
Croton River	23	338.8	49.4	22.8	26.6
Lake Cochituate	38	18.9	47.1	20.3	26.8
Sudbury River	26	78.2	46.1	22.6	23.5
Mystic Lake	18	26.9	44.1	20.0	24.1
Neshaminy Creek	16	139.3	47.6	23.1	24.5
Perkiomen Creek	16	152.0	48.0	23.6	24.4
Tohickon Creek	15	102.2	50.1	28.4	21.7
Hudson River	14	4,500.0	44.2	23.3	20.9
Pequannock River	9	63.7	46.8	26.8	20.0
Connecticut River	11	10,234.0	43.0	22.0	21.0
Chagres above Bohio	6	700.0	111.5	73.4	38.1

In round numbers, therefore, it appears that the valley of this tropical river has about 2.5 times the rainfall, about 3.3 times the outflow, and about 1.5 times the evaporation characteristic of the northeastern portion of the United States, and that ground water probably plays a much more important part in the regimen of the stream.

Now that the Panama Canal is about to pass under the control of the United States it is proper to state that to the wise forethought of Monsieur Maurice Hutin, the Director General, and of Monsieur Louis Choron, the Director of Investigations and of Construction, is due the credit for the exceptionally complete system of observations which renders possible a close study of every element involved in the preparation of the final plans for the completion of the canal. Such data is of vital importance, and could only have been secured by long years of labor.

RECENT PAPERS BEARING ON METEOROLOGY.

Dr. W. F. R. PHILLIPS, Librarian, etc.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a ——.

Quarterly Journal of the Royal Meteorological Society. London. Vol. 30.

Marriott, W. Some Account of the Meteorological Work of the late James Glaisher. Pp. 1-22.

—— Currents in the Arctic Ocean. P. 28.

Symons, G. J. Report on the Thunderstorms of 1857. Pp. 29-39.

Gibbs, L. Evaporation from the Land. [Note.] Pp. 39-40.

—— Meteorological Society of Japan. [Note.] P. 40.

Sutton, J. R. On Certain Relationships between the Diurnal Curves of Barometric Pressure and Vapour Tension at Kenilworth (Kimberley), South Africa. Pp. 41-53.

Bourhill, H. Curious Electrical Phenomena. Pp. 55-56.

SOLAR HALO OF FEBRUARY 4, 1904, AT MILWAUKEE, WIS.

By J. W. SCHAFFER, Observer, Weather Bureau, dated February 23, 1904.

This beautiful and interesting optical phenomenon was observed at Milwaukee, Wis., February 2, 1904. When first seen at 10:30 a. m., it appeared exceedingly well defined, and evidently had been visible for some time previous; it lasted with more or less distinctness till noon, then rapidly waned. The solar halo was of 22° radius, and was very distinct; upon the east, west, and north sides were mock suns of unusual brightness. Broad white bands of light extended from the sun to the several parhelia, and also to the southern side of the halo, radiating like the spokes of a wheel. A white band passed through the sun from the east to the west, and was projected around the entire heavens in a complete circumference about 45° from the horizon. At the extreme north point of this band a faint mock sun marked the intersection of some invisible halo. Twenty-two and one-half degrees on either side of this parhelion were two more of much greater brightness.

At the points where the white band left the solar halo, at either side, two tangential arcs appeared convex to the sun; one on the eastern contact with horns turned to the east; one on the western contact with horns turned to the west. A brilliant and highly colored arc, convex side to the sun, was tan-